

instead of 160, *i.e.* five vibrations too sharp, the two upper E's in the treble stave will clash, and a beat will result.

In all these three cases Smith's beats also will naturally be present, and it is curious that in each case when we come to determine the rapidity of the beats, we find it come out the same, whether we calculate it by Smith's formula or by the unison beats of Helmholtz's overtones. We have added the vibration-numbers to the notes, to facilitate the calculation, and we find the number of beats per second to be—

For the imperfect octave	...	...	...	= 5
For the imperfect fifth	...	...	...	= 10
For the imperfect major third	...	...	...	= 20

each arising from a sharpness of five vibrations in the upper note of the concord.

Hence we may lay it down as a principle that in consonances slightly out of tune, the beat given by the two fundamentals on Smith's plan, and those given by the first corresponding overtones on Helmholtz's principle, are synchronous, and may be considered identical.

The two kinds of beats, however, must not be confounded, as their cause is so distinct. The Helmholtz beats arise from the overtones only, whereas Smith's explanation applies to the fundamental notes, independently of the overtones altogether.

Helmholtz notices (Ellis's translation, pages 302-3) that beats of consonances will occur when sounded by simple tones, but accounts for them in another and very ingenious way, namely, by calling in the aid of the *grave harmonics*, or, as he calls them, the *combination tones*.

Taking our first example of the octave consonance given above, when the two notes of 128 and 261 vibrations are sounded together, they will give rise to a combination tone of 123 vibrations, and this, clashing with the 128 note, will give beats at the rate of five per second.

For the next example, the consonance of the fifth, this explanation will not suffice, and Helmholtz has to resort to a cause of the second order, namely, the beat of a grave harmonic, not with an imperfect unison, but with an imperfect octave. Taking our former example, an out-of-tune fifth C and G, of 128 and 197 vibrations respectively; these two notes will give a combination or difference tone of 69 vibrations, or an octave below the C, but out of tune. Then Helmholtz says this lower C will beat with its imperfect octave, on account of a new or second order of difference-tones formed from them, as in the former case.

In a similar but still more remote way, Helmholtz accounts for the beats of other consonances, the fourth, third, &c.

Without questioning the sufficiency of these explanations, I must say they seem to me somewhat far-fetched, and less satisfactory than Smith's, which account for the beats by a more positive and direct method, without calling in the aid of any sounds but the simple fundamental ones. There is at any rate the satisfaction that whichever explanation be adopted, the numerical value of the number of beats per second comes out the same and agrees with the fact; so that in a practical point of view it is immaterial which explanation be adopted.

I have alluded above to one important practical use of beats, namely, in tuning; but there is another use of them, also very interesting, *i.e.*, that they furnish a means of ascertaining the positive number of vibrations per second corresponding to any musical note. This may be done either by the unison or by Smith's beat, and I will give both methods.

For the unison beat:—Take two notes in unison on an organ, a harmonium, or other instrument of sustained sounds, and put one of them a little out of tune, so as to produce beats when they are sounded together. Let  $V$  and  $v$  represent the vibration numbers of the upper and lower notes respectively. Then by means of a mono-

chord it will be easy to determine the ratio  $\frac{V}{v}$ , which call  $m$ . Count the number of beats per second, which call  $\beta$ . Then, since  $\beta = V - v$ , we obtain the simple equation,

$$v = \frac{\beta}{m - 1}$$


which gives the actual number of vibrations per second of the lower note of the two.

The method of deducing the vibration-number from the Smith's beat was pointed out by Smith himself; but as this method, so far as I know, is not to be found anywhere, except buried under the mass of ponderous learning contained in his work; I give it here in a simple algebraical form. If  $\frac{m}{n}$  represents the true ratio of the interval,  $N$  the actual number of vibrations per second of the lower note, and  $M$  the same number for the upper one, the formula for Smith's beats becomes


$$\beta = \left(m - n \frac{M}{N}\right) N; \quad \text{or} \quad N = \frac{\beta}{m - n \frac{M}{N}}$$

Now, as  $m$  and  $n$  are both known for any given concord, if we can tell by any independent means the actual ratio of the notes  $\frac{M}{N}$ , we may, by simply counting the beats, calculate the actual number of vibrations  $N$  of the lower note. If the interval is too flat,  $\beta$  must be +; if too sharp, it must be —.

The following example will show how this may be done. Let it be required to determine how many vibrations per

second are given by the note  on an organ.

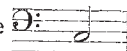
Tune three perfect fifths upwards, and then a perfect major

sixth downwards, thus—, which

will give the C an octave above the original note. But, by the laws of harmony, we know that this octave will not be in tune; the upper C will be too sharp, the ratio being  $\frac{81}{40}$ , instead of  $\frac{2}{1}$ , as it ought to be. Hence  $\frac{M}{N} = \frac{81}{40}$ ,

and  $\frac{m}{n} = \frac{2}{1}$ . Count the beats made by this imperfect octave, and suppose them = 192 per minute, or 3'2 per second; then, as the interval is sharp,

$$N = \frac{-3'2}{2 - \frac{81}{40}} = 128;$$

*i.e.* the note  is making 128 double vibrations per second.

This method has the advantage of dispensing with the use of the monochord, which was necessary in the former case.

## NOTES

A METEOROLOGICAL Commission, appointed by the Ministers of Public Instruction, Agriculture and Commerce, Marine, and Public Works, to inquire into the possibility and practicability of a more intimate co-operation being effected among the various meteorological systems of Italy, have just issued their report. The Commission consisted of fourteen members, including most of the well-known meteorologists of Italy, with Prof. Cantoni as president, and Prof. Pittel as secretary, and met daily at Palermo from Aug. 30 to Sept. 6, 1875. The more important of the conclusions arrived at are these:—That all methods of observing at the stations of the various systems connected with the State be

brought into accordance with those adopted by the Minister of Agriculture and Commerce; that harmonious action be based on the number, quality, and hours of the observations, a preference being given to those stations which from their position will best meet the requirements of local and international meteorology; that the instruments and modes of observing be strictly uniform; that inspection of stations be made at least once every two years, and that the reduction and publication of meteorological results be remitted to a directive council composed of meteorologists elected from the directors of the principal observatories and meteorological institutes, whose decisions will be carried out by a secretary and suitable staff.

At the meeting of the Paris Academy of Jan. 10, General de Nansouty submitted a report on the project of a physical observatory on the top of the Pic du Midi de Bigorre, Pyrenees. As our readers know, a small hotel on the Col de Sencours has been provisionally used for observations since 1873, but amid great difficulty, from avalanches, cold, &c. The Pic is 2,877 metres high, and only 527 short of the highest, but is easily accessible.

THE Observatory on the Puy de Dôme is being rapidly completed, and will be opened this year. A semaphoric system of telegraphy will be used to keep the Observatory in constant communication with Clermont, the chief town of the district, at the foot of the mountain.

THE fourth part of the second series of Mr. William H. Edwards' work on the Butterflies of North America has just been published by Hurd and Houghton, and contains five quarto plates of butterflies, drawn with the utmost excellence by Miss Peart. The forms illustrated are species of *Argynnis*, *Grapha*, *Melitæa*, and *Papilio*, most of them new species recently described by Mr. Edwards himself.

AN addition to the list of American scientific journals has been made in the form of a *Botanical Bulletin*, edited by Mr. John M. Coulter, of Hanover, Indiana. At present it is a sheet of four pages, appearing monthly, with the promise of increase in size with increase in subscribers. It is in form and general scope much like the Bulletin of the Torrey Botanical Club.

DR. HOFMANN of Berlin has been elected a foreign associate of the Italian Society of Science in room of the late Sir Charles Wheatstone. This Society was founded in 1782; the Italian members are limited to forty, and at present the Society has only twelve foreign associates, among whom are Sir George Airy, Prof. Cayley, and Sir Edward Sabine. Its rules are numerous, and somewhat stringent.

THE Paris Academy of Sciences at Monday's sitting nominated Prof. Nordenskjöld a Correspondant in the section of Geography and Navigation.

THE Central Section, or governing body of the Geographical Society of Paris, has appointed as its president for 1876 M. Malte-Brun, the son of the celebrated Danish geographer.

THE Geological Society of Paris has elected as its president for 1876 M. Pellat, an amateur geologist, holding a high position in the finance department of Government.

THE warlike habits of the Papuans and their implements of warfare are described in a private letter recently addressed to Dr. Hooker. The writer says that no man leaves his dwelling for his bit of cultivation even without his powerful bamboo bow and a few deadly poisoned arrows. These poisoned arrows are only a few amongst a great number not poisoned, the former being distinguished by elaborate carving and painting, probably to prevent accident amongst themselves. They are each pointed and barbed with human bone brought to almost needle-like sharpness, most carefully and neatly finished; they are poisoned by

plunging in a human corpse for several days. Poor Commodore Goodenough and his men suffered from arrows so poisoned. It is a sort of blood-poisoning that, like other kinds of inoculation, does not develop itself for several days, the slightest scratch being sufficient to render almost inevitable a horrible death. The symptoms are accompanied by violent spasms like tetanus, with consciousness until the last.

CAPTAIN MORESBY'S work on New Guinea and Polynesia will be published shortly by Mr. John Murray. It will include discoveries and surveys in New Guinea and the D'Entrecasteaux Islands, a cruise in Polynesia, and visits to the pearl-shelling stations in Torres Strait of H.M.S. *Basilisk*, and will be illustrated by a map and wood-cuts. It will be interesting to compare this book of Captain Moresby's with Captain Lawson's "New Guinea," noticed in NATURE some time back.

M. E. QUETELET has called attention to the cold experienced in Brussels in December, 1875, when the temperature fell to freezing every night from 25th Nov. to 6th Dec., falling on the 2nd to 18°·5, which is lower than has occurred any time up to the 4th December, during the last forty-two years. In thirteen out of the forty-two years the temperature observations present a relation somewhat analogous to those of 1875. It is remarkable that with this low temperature and a persistent E.N.E. wind, the barometer has continued low and the air humid and constantly cloudy. On the 7th December the temperature fell to 5°·9.

PROF. F. W. PUTNAM, Dr. Packard's late colleague, the *Nation* announces, has been appointed Civilian Assistant on the U.S. Surveys west of the 100th meridian conducted by Lieut. G. W. Wheeler, and is already occupied in preparing a report on the abundant and very valuable archaeological and ethnological material collected by the exploration in Arizona, New Mexico, and California. The report will be profusely illustrated, and the *Nation* ventures to predict, will be the beginning of our scientific knowledge of the prehistoric civilisation of the above-named regions.

A CONVOCATION of the University of London was held on Tuesday, at which, after a long discussion, a resolution was passed affirming the desirability of obtaining a new charter, and declaring that no such charter would be acceptable to convocation which did not enable the University to grant degrees to women.

THE Ladies' Classes at University College, London, began on Monday last the second term of their eighth session. There was a slight decline in the number of students for the session 1874-75, but the first term of the session 1875-76 showed a considerable advance beyond the highest success hitherto attained. In the Michaelmas term, 1874-75, the whole number of individual students was 199; in the Michaelmas term, 1875-76, just elapsed, the number of individual students was 265. The whole number of tickets taken in Michaelmas term, 1874-75, was 257; in the same term of 1875-76 it was 367.

IN a paper on the Chalk in the Channel district read at the Paris Academy on Monday, Prof. Hebert stated that he expected great obstacles to be met with in the attempt to bore a Channel tunnel.

IT is announced that all communications and notifications in connection with the next International Congress of Medical Sciences, to be held at Geneva on Sept. 9, 1877, be sent to the Committee before June 1, 1876, the time when the Committee will definitely settle the regulations and programme, and appoint reporters. The present president is Prof. C. Vogt, and the secretary Dr. T. L. Prevost.

M. ADOLPHE PICTET, who died at Geneva on Dec. 20 last, at the age of 76 years, was one of the most eminent writers on



ethnology and comparative philology of the present century. In 1839, the French Institute awarded him the Volney Prize for his work on the affinity of the Celtic Languages with Sanscrit. In 1863, this same prize was awarded him a second time for the publication of his great work, "Les Origines Indo-Européennes, ou les Aryas primitifs." M. Pictet was also an eminent man of letters. He was a corresponding member of the Royal Society of Edinburgh.

AN ingenious toy, apparently of Japanese origin, has recently been introduced into London. It consists of a small picture, on paper, of an individual pointing a firearm at an object—bird, target, or second person. By the application of the hot end of a match, just blown out, to the end of the gun, the paper commences to smoulder towards the object aimed at, and in no other direction. When it is reached a report is heard from the explosion of a small quantity of fulminating material. The toys are sold in London by Mesdames Jinks and Ashton, of Glasshouse Street.

ABOUT midnight on the 22nd of December, 1875, two earthquake shocks were felt at Washington, Richmond, Weldon, North Carolina, U.S., and other places in that section. There were two distinct shocks at Richmond, the first continuing about ten seconds, while the other was briefer and not so severe, and was accompanied by a concussion in the air.

THREE distinct shocks of an earthquake are stated to have been felt at Comrie, near Crieff, Perthshire, on Sunday—two at about three in the morning and the third in the afternoon.

THE *Gazette d'Autbourg* states that a commission which has been visiting the Russian Universities has laid its report before the Czar. The chief recommendations are to increase the salaries of some of the professors, and to create a few new chairs.

THERE are several important papers in this month's part of Petermann's *Mittheilungen*. The editor himself takes occasion, on the conclusion of the new edition of Stieler's fine Hand-Atlas, to give a brief history of that work, and to point out the great advances in geography since the last edition was published. The first part of a paper appears, giving some account of Przewalsky's travels in Mongolia and the land of the Tanguts during 1870-73. We believe the author's narrative of this important expedition is being translated into English; a map accompanies the article in the *Mittheilungen*. A translation from the Russian gives an interesting description of the ruins of Mestorján, in the Turkoman steppes. Some account of the Paris Geographical Congress is given by the delegates from Perthshire establishment. A valuable paper by Dr. G. Hartlaub describes the great amount of work done by that indefatigable traveller in China, the Abbé Armand David. Along with a brief summary of discovery in the interior of Australia there is a fine map, showing the routes of Warburton, Forrest, and Giles.

SUPPLEMENT No. 44 of Petermann's *Mittheilungen* contains the first part of a narrative of the expedition which, under the engineer Josef Cernik, in 1872-73, explored the region of the Euphrates and Tigris, for the purpose of estimating its industrial capacities, and to mark out a route for a railway. The narrative will be found to contain much valuable information on the various aspects of the region visited. We need hardly say the narrative is accompanied by admirable maps.

THE Japanese Government is said to have adopted a singular method for extending a knowledge of the Arabic numerals with their English names; these are printed on cloth, which is sold at a low price to the peasantry.

THE *Annuaire* of the Bureau des Longitudes for 1876 was published a few days ago with an unusual number of useful tables and a map showing the magnetic declination for all French towns.

M. WALLON, the French Minister of Public Instruction, has abolished the fees of the several examiners in the degree examinations in Law, Medicine, Science, Literature, and Theology. The salaries of the professors and fellows have been raised on a scale varying from 6,000 francs to 18,000 francs, the professors of theology excepted. It is believed that these reforms are preparatory to the gratuitous conferment of degrees, which will be instituted by the new assembly.

WE have received the "Transactions" of the Clifton College Scientific Society, vol. ii. part 1, including the period from Dec. 1872 to June 1875. There are a number of very fair papers, though it seems to us that the members generally need to be awakened up and urged to attempt to rival similar societies in some of our other public schools. The "Transactions," however, contain one paper which alone reflects great credit on the Society, and especially upon its author, R. A. Montgomery. The paper is on the Isle of Unst, in Shetland, and describes, from personal observation, its geology, natural history, antiquities, and scenery, in a manner which would entitle it to a place in the "Transactions" of a more ambitious society. The paper is illustrated by maps and a section.

AN important publication has lately been commenced in the form of a Bulletin of the U.S. National Museum, consisting of a series of memoirs illustrating the collections of the museum. It is printed, by direction of the Secretary of the Interior, at the Government printing-office, from materials prepared by the Smithsonian Institution, which, as is known to our readers, has charge of the museum referred to. The first number of the *Bulletin* consists of a check list of the North American batrachia and reptilia, with a systematic list of the higher groups, and an essay on geographical distribution, as based on the specimens in the National Museum, and as prepared by Prof. Edward D. Cope, the well-known herpetologist and naturalist. The list of species is the first systematic enumeration of American reptiles since the time of Dr. Holbrook, and embraces 101 species of frogs, toads, salamanders, &c., 132 of serpents, 82 of lizards, 41 of turtles and tortoises, and 2 of crocodiles. Each species is accompanied by a reference to some work where it is described or figured. The list of the higher groups embraces those of the whole world, and will form a convenient basis for the arrangement of such collections in public museums.

THE scientific expedition, commanded by M. Mouchez for the survey of the coast of Algeria, will last ten months. During the latter part of the expedition M. Mouchez will resume the exploration of coral reefs, and will be accompanied by M. Lacaze-Duthiez.

MR. J. CLIFTON WARD has reprinted from the *Quarterly Journal* of the Geological Society his paper "On the Granitic, Granitoid, and Associated Metamorphic Rocks of the Lake District."

THE tenth edition of the Prospectus of Sir Joseph Whitworth's Scholarships for Mechanical Science has been issued, containing the papers set at the examinations in May 1875.

ON the 26th of November last, in the French island La Réunion, near Mauritius, a part of a mountain slipped down, seventy-two persons having been crushed by the falling rocks.

THE additions to the Zoological Society's Gardens during the past week include an Emu (*Dromaeus novaehollandiae*) from Australia, presented by Mr. E. J. Dawes; a Palm Squirrel (*Sciurus palmarum*), a Manyar Weaver Bird (*Ploceus manyar*), two Nutmeg Birds (*Munia undulata*), two Amaduvade Finches (*Estrela amadava*) from India, presented by Mr. W. D. Baker; a Cinereous Sea-Eagle (*Haliaeetus albicilla*), European, deposited.